[0052] FIG. **12** depicts a plot of the input power matching of the band filter **1000**. Although switch resistance degrades the matching performance, the bandwidth of the matching may remain relatively constant.

[0053] In the case of a cross-coupled bandpass filter, the transmission zeros may be tuned by coarsely adjusting the characteristic impedance of the transmission lines that embody the phase shifter. For the band filter **1000** example depicted at FIG. **10**, equal characteristic impedances for both L_{13} and L_{35} inductors may allow the two transmission zeros to be co-incident.

[0054] FIG. **13** plots the forward transmission of the band filter **1000** example depicted at FIG. **10** with co-incident transmission zeros. FIG. **13** shows that the selectivity rate may only slightly degrade with increased resistance, which may be similar to the separated transmission zero example noted above. The exact location of the transmission zeros may not vary with resistance but may be finely adjusted via tuning capacitors (for example, capacitors **1018**A-**1018**B at FIG. **10**).

[0055] FIG. **14** depicts a plot illustrating input power matching performances for the co-incident nulls scenario, and that it yields the same operational trend as the non-co-incident scenario. Therefore, the phase shifters disclosed herein may be used to form tunable inductor components for tunable front-end filters, for example.

[0056] FIG. **15** illustrates a block diagram of an apparatus **10**, in accordance with some example embodiments. For example, apparatus **10** may comprise a user equipment, such as a smart phone, smart object, mobile station, a mobile unit, a subscriber station, a wireless terminal, a tablet, a wireless plug-in accessory, or any other wireless device.

[0057] The apparatus **10** may include at least one antenna **12** in communication with a transmitter **14** and a receiver **16**. Alternatively transmit and receive antennas may be separate. The tunable phase shifters disclosed herein may, in some example, embodiments, be used to provide a tunable filter at for example transmitter **14** and/or as a duplexer between the receiver **16** and transmitter **14**.

[0058] The apparatus **10** may also include a processor **20** configured to provide signals to and receive signals from the transmitter and receiver, respectively, and to control the functioning of the apparatus. Processor **20** may be configured to control the functioning of the transmitter and receiver by effecting control signaling via electrical leads to the transmitter and receiver. Likewise, processor **20** may be configured to control other elements of apparatus **10** by effecting control signaling via electrical leads connecting processor **20** to the other elements, such as a display or a memory. The processor **20** may, for example, be embodied in a variety of ways including circuitry, at least one processing core, one or more microprocessors with accompanying digital signal processor(s), one or more processor(s) without an accompanying digital signal processor, one or more coprocessors, one or more multi-core processors, one or more controllers, processing circuitry, one or more computers, various other processing elements including integrated circuits (for example, an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), and/or the like), or some combination thereof. Accordingly, although illustrated in FIG. **15** as a single processor, in some example embodiments the processor **20** may comprise a plurality of processors or processing cores.

[0059] Signals sent and received by the processor **20** may include signaling information in accordance with an air interface standard of an applicable cellular system, and/or any number of different wireline or wireless networking techniques, comprising but not limited to Wi-Fi, wireless local access network (WLAN) techniques, such as Institute of Electrical and Electronics Engineers (IEEE) 802.11, 802.16, and/or the like. In addition, these signals may include speech data, user generated data, user requested data, and/or the like.

[0060] The apparatus **10** may be capable of operating with one or more air interface standards, communication protocols, modulation types, access types, and/or the like. For example, the apparatus **10** and/or a cellular modem therein may be capable of operating in accordance with various first generation (1G) communication protocols, second generation (2G or 2.5G) communication protocols, third-generation (3G) communication protocols, fourth-generation (4G) communication protocols, Internet Protocol Multimedia Subsystem (IMS) communication protocols (for example, session initiation protocol (SIP) and/or the like. For example, the apparatus **10** may be capable of operating in accordance with 2G wireless communication protocols IS-136, Time Division Multiple Access TDMA, Global System for Mobile communications, GSM, IS-95, Code Division Multiple Access, CDMA, and/or the like. In addition, for example, the apparatus **10** may be capable of operating in accordance with 2.5G wireless communication protocols General Packet Radio Service (GPRS), Enhanced Data GSM Environment (EDGE), and/or the like. Further, for example, the apparatus **10** may be capable of operating in accordance with 3G wireless communication protocols, such as Universal Mobile Telecommunications System (UMTS), Code Division Multiple Access 2000 (CDMA2000), Wideband Code Division Multiple Access (WCDMA), Time Division-Synchronous Code Division Multiple Access (TD-SCDMA), and/or the like. The apparatus **10** may be additionally capable of operating in accordance with 3.9G wireless communication protocols, such as Long Term Evolution (LTE), Evolved Universal Terrestrial Radio Access Network (E-UTRAN), and/or the like. Additionally, for example, the apparatus **10** may be capable of operating in accordance with 4G wireless communication protocols, such as LTE Advanced and/or the like as well as similar wireless communication protocols that may be subsequently developed.

[0061] It is understood that the processor **20** may include circuitry for implementing audio/video and logic functions of apparatus **10**. For example, the processor **20** may comprise a digital signal processor device, a microprocessor device, an analog-to-digital converter, a digital-to-analog converter, and/or the like. Control and signal processing functions of the apparatus **10** may be allocated between these devices according to their respective capabilities. The processor **20** may additionally comprise an internal voice coder (VC) **20***a*, an internal data modem (DM) **20***b*, and/or the like. Further, the processor **20** may include functionality to operate one or more software programs, which may be stored in memory. In general, processor **20** and stored software instructions may be configured to cause apparatus **10** to perform actions. For example, processor **20** may be capable of operating a connectivity program, such as a web browser. The connectivity program may allow the apparatus **10** to transmit and receive web content, such as location-based content, according to a protocol, such as wireless application protocol, WAP, hypertext transfer protocol, HTTP, and/or the like.